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Next 1 Page(s) In Document Denied

THE ROLE OF THE CENTRAL PHYSICAL RESEARCH LABORATORY IN THE
DEVELOPMENT OF PHYSICAL RESEARCH IN HUNGARY SINCE THE LIBERATION

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In order to gain a proper understanding of the development of physical research in Hungary one must first review briefly the conditions which prevailed prior to Liberation. The status of physical research was determined by the social and economical condition of the country. In the unindustrialized country, under strong German-Austrian influence, led by high uncultured governing circles, the natural sciences, and especially physics, were undeveloped. From the turn of the century until the 1920's there were perhaps 3 physicists of European reknown in Hungary, Lorand Eotvos, Gyoze Zemplen, and Gula Farkas. One of the greatest faults of this period was that the Hungarian physicists of that time did not gear themselves to the most important, the leading research of those times. In those times, whoever wanted to pursue modern physics went abroad (viz. Todor Karman).

There was no great change in this situation during the Horthy regime, although certain capital interests (viz. the Unified Incandescent Corporation) played an important role in the early development of Hungarian physics. However, the general picture was that the country continued to be exceptionally undeveloped industrially, remained at the mercy of the foreign capital interests, and therefore was in a position in which the foreign interests did not want to, and the smaller domestic capitalists were unable to finance physical research. Thus no one undertook the support of experimental physical research, the results of which would benefit industry.

STAT

There was another reason for the undeveloped state of physical research (and of the natural sciences in general). Wide-scale dissemination of knowledge of the natural sciences would have been dangerous to the ruling classes, because "state citizens" armed with the culture of the natural sciences would have proved quite disturbing to the ruling class of the "legal-culture" of gentry Hungary. At that time "cultured" men boasted of the fact that they hardly understood, and never liked physics and mathematics in the middle schools and higher schools, and did not consider it a mark of lack of culture if a person was ignorant of Newton or of the law of gravity. However, one might be scorned if perchance he was not familiar with a relatively lesser German poet or with a large part of his poetry.

Therefore the only place where experimental physics could enjoy serious development in Hungary was the Unified Incandescent Plant which was owned by foreign capital interests. The research which was conducted here, chiefly by Imre Brody and Pal Selenyi, are among Hungary's greatest heritage in the field of physics. A sizeable portion of the presently active experimental physicists either grew up in the research laboratory of the Unified Incandescent Plant, or are pupils of physicists who grew up in that laboratory (Peter Farago, Jeno Pocza, Karoly Simonyi, Gyorgy Szigeti, etc). Those research themes which were in some way connected to industrial problems were developed, also, though on a limited scale, at academic chairs (Zoltan Gyulai, Bela Pogany). A definite new level was reached when individual young physicists succeeded in studying abroad and bringing modern experimental physics methods to Hungary with them upon their return (Rezso Schmid, Sandor Szalay). Another beneficial effect of the latter process was the establishment of an internationally renowned young guard of experimental physicists (Laszlo Bozoky, Lorand Gero), and theoretical physicists closely allied to experimental physics (Agoston Budo, Istvan Kovacs).

The situation was no better in the field of theoretical physics. The situation in this field of physical research is characterized by the fact that in 1926 theoretical physics was taught at the Budapest University by a professor who not only presented no material on atomic theory, but did not even believe in the electromagnetic theory of light. Modern theoretical research began in the ranks of the young researchers who were beset with great financial need and did not receive the support of the reigning circles (Pal Gombas, Tibor Neugebauer, Karoly Novobatzky), and who rapidly achieved international reknown. During this period numerous capable Hungarian physicists emigrated abroad because they could not succeed in Hungary under the Fascist political system of Horthy (Gyorgy Hevesy, Lanczos Kornel, Janos Neumann, Leo Szilard, Ede Teller, Laszlo Tisza, Jeno Wigner, etc). According to famous foreign physicists if all the Hungarian physicists presently living abroad could be gathered in one place, one could found an institute which no existing institute could match for scientific excellence in the world.

The Horthy epoch had a disastrous effect on the development of the physical sciences through its material and personnel hindrances. All in all, physics in Hungary is far behind the foreign level both in research and in instruction.

The Liberation of Hungary was the turning point which signalled the upswing in development of the natural sciences, including physics. Because of the financial straits immediately following Liberation, however, the status of physical research (which now demands great material and technical resources) deteriorated. The status of the country at that time did not permit the commencement of research which would require such heavy outlay. However, as soon as the governmental problems were solved and the

finances of the country improved, the Government extended much greater aid to Hungarian science, and primarily to physical research, than it had ever received before.

Until as late as 1949 Hungarian higher education had not even posed the question of whether it is necessary to train physicists at the universities, these physicists who solve the ever increasing new problems created by the introduction of new technologies, in the research institutes and in industrial plants. A grave error was committed in the introduction of the training of physicists at the universities, in that the aims and the methods of the training of physicists was not established. Despite the latter, however, the mere fact that the training of physicists at the universities was begun at the same time as the beginning of the Five-Year Plan signified that the personnel prerequisites of the development of physical research had appeared.

The first step in the actual commencement of research was the furthering of the idea that physical research, provided with greater material and technical resources, and relying on the existing scientific personnel, should achieve world renown in several fields. For the solution of this task the State created, in mid-1950, the Central Physical Research Institute (KFKI) under the Hungarian Academy of Sciences. With this move the Government intended to achieve the goal in which the physical research is provided with the means, with the aid of which outstanding research physicists may develop. Thus both the personnel and material prerequisites for the development of physical research had appeared.

The KFKI concentrated first on the development of experimental physics. This decision was indicated by the fact that while several small schools of followers had formed around individual theoretical physicists, the field of experimental physics was entirely lacking in material support, as already has been described above. In addition to the general aim (that the KFKI should be concerned primarily with research in experimental physics) a detailed profile of research had to be developed. The latter task, however, was neglected during the first period, partly because no one could see the effect which the as yet undeveloped physical science would have on the development of the people's economy. The construction of such a profile would have been especially important in the case of Hungary, because the expansion and assignment of the industrial basis and the industrial connections necessary for experimental research require long periods of time.

Thus to a certain extent it is understandable that an attempt was made to consolidate under the Institute the various research groups which were more or less attached to individual university institutes but which lacked adequate material support. The theory was that when better supplied these research groups could develop more advantageously, and those which showed promise could form the seed for individual departments of the KFKI. Under the given circumstances this seemed to be the solution which had the most to offer for the greater development of experimental physics. Thus at the very beginning, the individual research groups were added to the Institute not on the basis of their research themes, but because of the mere fact that they were conducting experimental research. Unfortunately, the research groups which were acquired from university institutes weakened the physical research work of the universities by their leaving. The risk of such a temporary weakening had to be taken, however, because it would have been impossible for modern experimental research to develop in the academic field because the few, scattered research groups could not receive the material support which they received under the KFKI. In the future this weakening must

STAT

be corrected by the research groups, which have been strengthened and have attained modern levels within the KFKI, taking a more active part in the life of the university.

To start with, the KFKI organized those departments which already had an academic tradition, for which there were trained scientific leaders available, and the research teams of which already had worked together at the universities. The first department to be formed was the Department of Spectroscopy, headed by Istvan Kovacs. The establishment of this department was based chiefly on heritage of the experimental spectroscopic research of Schmid and Gero at the Polytechnical University, and the heritage of the theoretical work of Budo and Kovacs. The work of Schmid and Gero included the experimental investigation of the spectroscopic images of biatomic molecules. Most of their work concerned the term pattern of the carbon monoxide molecule, and they solved problems of this nature which surpassed the problems of the spectroscope, by applying the theory of chemical binding. The investigations also extended to include the NO, N₂, CN, O₂ molecules and the biatomic hydrides. They also performed other types of spectroscopic investigations, i.e., Zeeman-effect investigations. Their central problem throughout remained the chemical binding of molecules. In addition to his scientific work, another great accomplishment of Rezső Schmid was his training of young scientists. He created the science of spectroscopy in Hungary, not only in his own person, but he collected an entire school of followers, whom he trained tirelessly. His training of his associates consisted not only of merely giving directions, but he took active part in the students' work. It was all due to Rezső Schmid that the initial equipment necessary for beginning spectroscopic research was available, and that the research personnel of the school founded by him enabled the recommencement of research in this field. It is an important fact that the KFKI was able to offer possibilities to certain researchers of the old spectroscopic school who in many cases had been deprived the advantages of modern scientific work, and who were working amid surroundings unbefitting their capabilities. Thereafter, spectroscopic research has been based on much broader fields than before, in that industrial and absorption spectroscopic research were added to the pre-liberation field of molecular spectroscopy.

The recommenced molecular spectroscopic research may be considered to be a direct continuation of the experimental work of Schmid and Gero and the theoretical work of Budo and Kovacs. In the experimental field, work continued on the investigation of the spectrum bands of biatomic molecules, principally SrO, BiO, etc, and work on the theoretical level concerned the determination of the internal structure of molecules. Some important investigations of the latter involve the perturbations observable in the spectrum bands of molecules, the theoretical evaluation of which may yield quantitative information on the structure of molecules.

Significant developments in the field of industrial spectroscopy included the further perfection of the necessary technical equipment, the domestic manufacture of carbon with an adequately pure spectrum band, and the development of the new spectrochemical analytical methods.

In the field of absorption spectroscopy the research has chiefly concerned the problems of the structure of organic compounds. Significant results have been achieved in the methods of measurement in absorption spectroscopy, and in the physical-chemical application of the results obtained.

One of the crucial points taken into consideration in the founding of the KFKI was the fact that László Budo, who is one of the leading

STAT



cosmic ray researchers of the world and who had been driven out of Hungary by the fascism of the Horthy Regime, had returned to Hungary. Some research had been done on cosmic radiation prior to liberation by Jenő Barnóthy and Magdolna Forró at the University of Budapest. However, because of the lack of financial support to scientific research at that time the latter research was of no more significance than the experimental research which was conducted in other fields at that time. Following liberation, research in cosmic radiation was recommenced at the University of Budapest, but due to the financial straits the experimental work was limited to the coincidence-linkage of Geiger-Müller tubes. The research work had 2 aspects, the development of experimental technique, and the investigation of cosmic radiation. On the one hand investigations were conducted at sea level on cosmic radiation measured through its absorption in lead, and on the other hand measurements were made in mine shafts to determine whether the particles involved in cosmic rays detected in the depths of the earth were the same as those measured at sea level, and therefore consist of mesons. The absorption measurements executed at great depths were in accord with the hypothesis that these mesons originated in the atmosphere and passed through the entire earth layer covering the mine shaft to the point of measurement.

In 1950 there was a crucial change in cosmic radiation research in Hungary. Repatriated Lajos Janossy devised a research program with a broad perspective, and directed primarily at research on the extensive cosmic showers. The particles which cause these extensive showers have exceptionally great energy, and research along this line may lead to the discovery of new types of nuclear processes and possibly to the discovery of new elementary particles. There is also hope that the investigation of these extremely large energies may result in the acquisition of new nuclear data which may enable further development of nuclear theory.

The government considered it very important that facilities be provided for Janossy which would enable him both to continue his world-famous experiments and to continuously train beginning scientists into accomplished physicists. For this purpose the Cosmic Radiation Department of the KFKI was established, the first task of which was the preparation of the measuring equipment necessary for the research work, and the training of scientific associates. For the furtherance of the above a new building of the Cosmic Radiation Department was completed in 1951 at Csilleberek, a 32 m deep shaft was dug, which is unique in its field, and a wooden building of special design was built for the purposes of cosmic radiation research, where the actual measurements are made.

The work of the Cosmic Department began with development of experimental technique. The first projects concerned the mechanics of discharge of Geiger-Müller tubes and the electronic equipment connected to the GM tubes. The semi-factory scale manufacture of GM tubes used in the measurement of cosmic radiation was a central problem. This problem now may be considered solved. The electronic equipment used in the measurement of extensive atmospheric showers, and the Wilson chamber necessary for investigation of the atomic nuclear processes which occur in the latter were built. In addition to investigation of the extensive showers, the research program of the Department also includes investigation of problems connected with the disintegration of μ -mesons. The first results of investigations along this line were data pertaining to the life span of μ -mesons which have been registered and accepted in the scientific literature. Theoretical investigations are closely tied in with the experimental research on cosmic radiation. These theoretical investigations are concerned primarily with problems of the cascade theory.

In addition to the former, research is being conducted under the direction of Janossy on clarification of the theoretical bases of the theory of relativity. Optical experiments related to the latter research also are being conducted at the Department.

Under the leadership of Lajos Janossy the Electromagnetic Waves Department was founded in the spring of 1951, with the intention that this department would be concerned chiefly with the solution of theoretical problems encountered in the work of the Telecommunications Research Institute. There was practically no scientific heritage in the field of microwave research in Hungary, and those scientists who worked on Radar problems during World War II already had been located with other institutions. Therefore it was apparent that the research problems of this field of science could be most easily absorbed and reviewed by scientists who had similar research experience in some other field of electronics. Thus in the organization of this department the small group which had begun to form around Peter Farago and Jano Pocza at the University of Budapest was chosen to form the core of the department, and the work of the group was based on the work of these 2 leaders at the research laboratory of the Unified Incandescent Plant. Not quite one year later Peter Farago assumed the leadership of the Department. Before long it became apparent that the original conception of the work of this department was based on a complete misunderstanding of the internal dialectic of scientific development. A definite basis had to be worked out first in the field of the physics of microwave phenomena in order that aid may be extended to a technically well-developed institute in the clarification of the theoretical bases of practical problems. However, the Department successfully coped with its own difficulties and is now on the right path. The Department intends to conduct theoretical research in several important fields of the physics of microwave phenomena.

Even before the formation of the Department investigations on the determination of the magnetic force of atomic nuclei which had been initiated at the Polytechnical University were continued, as well as work on the clarification of certain problems of the structure of substances (chemical binding). The equipment necessary for these investigations was constructed and the first research results already have been achieved. Preparations are being made for investigations involving similar methods in the microwave range, also. Microwave spectroscopic equipment is being built which will enable investigation of problems of molecular structure and the results of this investigation will enable the drawing of conclusions of importance to nuclear physics.

Undoubtedly the most important achievement of physical science during the past 2 decades was the liberation of atomic energy. The author is convinced that the peaceful use of atomic energy will be one of the most important questions of the immediate future. It would have been a mistake to overlook this fact when discussions were begun on the commencement of large scale experimental physical research in Hungary. However, the peaceful use of atomic energy is not a simple academic problem, and the treatment of this problem may not be limited to one institute. The peaceful application of atomic energy affects the entire people's economy, and the preparation for peaceful utilization of atomic energy is a gigantic task of the national economy. However, the execution of this task necessarily involves consideration of the scientific aspects of the problem. It would be a mistake to think that the nuclear research problems themselves would solve the problem of the creation of the facilities for the solution of this task. In the era of the peaceful use of atomic energy all the major branches of modern physics should be further developed (spectroscopy, cosmic radiation research, radiology, etc). However, Hungary must not allow her forces to be divided, and therefore she must

STAT



prepare for the peaceful use of atomic energy. The country in which she already has a scientific heritage, scientific experts and economic resources. The peaceful use of atomic energy involves 3 major problems: the problem of raw materials, the problem of ensuring an adequate industrial background with the necessary enormous technological developments, and development of modern experimental physics. A scientific institute can be concerned only with the latter problem. Concerning the first 2 problems, considering the circumstances of Hungary, these problems can be solved only through cooperation with other countries, primarily the Soviet Union. There had been certain traditions of atomic physics research in Hungary, which were brought to this country by Zoltan Bay and Sador Szalay when they returned from foreign travels. The research of Zoltan Bay was concerned chiefly with the construction of nuclear acceleration equipment, however, his lack of success in this field is attributed mainly to the war-like conditions prevailing at the time, and to inadequate funds. At any rate this research was beneficial in that it helped train young physicists who could achieve results when adequate material support is available. This group included Karoly Simonyi, who became head of the Atomic Physics Department of the KFKI in 1952. Through the KFKI it became possible for the first time to build expensive atomic acceleration equipment. The building of this type equipment requires much more time, experience and material than the building of equipment for other types of research. Within a relatively short time a 1 mv open-air linear generator, an 800 kv cascade generator together with an acceleration tube for the acceleration of heavy particles, have been built and a 4-mv pressure tank generator and a 600 kv new cascade generator are presently under construction. The open-air generator was built for the acceleration of electrons, and is used for the production of very hard gamma rays. In the future this instrument will be used in the investigation of the braking radiation of high-energy electrons. The 800 kv cascade generator is being used as a neutron source, and by 1955 it will be used in the production of radioactive isotopes. The tension portion of the 4 mv tank generator was completed by the end of 1954, and in addition to scientific research this instrument also can be used for the production of radioactive isotopes. In the building of the above equipment the construction of certain auxiliary instruments also was necessary, such as the building of a small mass-spectrograph, equipment for the production of heavy water, etc. Research on atomic nuclei can begin only after the above instruments are built and completed.

The second research center was formed at Debrecen, under the leadership of Sador Szalay. Even before Liberation Szalay was conducting atomic physics research of a type which could be performed with relatively simple and inexpensive equipment. Szalay and his associates were concerned chiefly with the determination of excitation functions related to atomic transmutation. Following Liberation they broadened their field to include radiological investigation of rock formations, and the possibilities of the use of radioactive isotopes in Hungary. Their radiological petrographic examinations were concerned primarily with determination of the uranium content of domestic coal. In 1954 the government established the Atomic Nuclear Physics Research Institute at Debrecen for the continuation and expansion of these investigations.

The research of the Atomic Physics Department of the KFKI and of the Atomic Nuclear Physics Research Institute at Debrecen are mutually supplementary and are coordinated through the Hungarian Academy of Sciences.

Radioactive isotopes are utilized in the fields of industry, agriculture and national defense of all advanced countries. Radioactive isotopes are used in investigations in practically all branches of science and in

the solution of industrial and agricultural problems (not to mention the aspect of national defense) in all countries with well-developed research. The methodology of the application of radioactive isotopes in research is still a relatively new field. The various fields of research necessitates the use of extremely varied types of radioactive isotopes, and the economical production of large amounts of these isotopes is possible only in an atomic pile. Because of this fact this type of research has no traditional heritage in Hungary. Nevertheless it is worthy of mention that the isotope tracer technique was founded by Nobel prize winner Gyorgy Hevesy, a Hungarian emigre.

The above considerations led to the necessity of the founding of the Radiological Department of the KFKI, which began its operations in the fall of 1952 under the direction of Laszlo Bozoky. At the very beginning of its operations this department was assigned concrete tasks for the design of radiation protection measurement instruments. The original conception was that after a short period of development isotopes with a short half-life could be produced with the acceleration equipment of the Atomic Physics Department, and the isotopes which can be produced only in atomic piles would be acquired from the Soviet Union. In the preparation for this epoch it was considered of prime importance that the appropriate instruments be available in proportion to the above developments, and that the Department train physicists with experience in such measurement procedures. This conception was partially realized with the arrival of the first shipment of isotopes from the Soviet Union. These isotopes were installed in the isotope laboratory of the Institute, which up to that time was built up as a model laboratory, and from where the isotopes are shipped, together with measuring instruments constructed within the Institute, to the various medical and other research sites. Following the preparatory stage of developmental work, research along this line can begin only now, when the various beta and gamma particle-indicating GM-tube and ionization chamber instruments have been built, and the various mechanical and electrical equipment has been perfected, along with the pocket-sized self-indicating and nonself-indicating daily tolerance radiation protection devices, etc.

To a certain extent it is a peculiarity of the field of physics that theoretical and experimental research differ greatly with respect to methods and to research personnel. Although the task of the KFKI is the development of experimental physical research, it is apparent that a high level of physical research can be attained only if experimental research is supported, directed and followed by a high level of theoretical work. Thus from the point of view of the KFKI the status of Hungarian theoretical physical research is a matter of no mean importance and in fact it is of prime importance to the Institute that the domestic theoretical physicists add their support to the experimental physical research being conducted at the Institute.

An independent theoretical group consisting mainly of students of Novobatzky joined the work of the KFKI with the expressed purpose of initiating theoretical atomic physical research in Hungary. This group recently has merged with the Cosmic Radiation Department, and at present is conducting its research within that department. In a larger perspective nuclear theory is one of the most important and at the same time one of the most significant branches of theoretical physics, and the intensive development of this branch of science in Hungary is very desirable. This group has succeeded in achieving several important results in the field of the skin structure of atomic nuclei and the nature of atomic nuclear forces, through which the group has joined in the world-wide active research along this line. It is a welcome fact that the theoretical atomic nuclear physics group still maintains very



close scientific cooperation with the academic chair of theoretical physics headed by Novobatzky.

One of the most important methods for the establishment in Hungary of the new branches of research is to send young physicists abroad for training in these fields. As mentioned above, the development of those fields of research was most rapid in the period following Liberation in which there were accomplished Hungarian researchers or young physicists who had been trained in the schools of such researchers. This method must be applied in the future, also. Unfortunately up to the present time this method of development has been followed only to a very small degree. In the fields in which this was done, however, initial results already have been achieved. In the fall of 1953 Pal Lenard returned from the Soviet Union where he had taken his candidate's degree, and the Department of Magnetism was founded under his leadership, the task of which is to extend aid in the future to telecommunications and radio-physics research through conducting theoretical research on the physics of ferromagnetic substances.

The combined activity of physicists and engineers in the field of modern experimental physics was first realized in Hungary within the KFKI. In the interest of the achievement of a high quality research level an attempt was made to utilize the most modern methods possible in all fields and outmoded and inefficient methods were not tolerated. Prior to Liberation experimental physics was greatly retarded by the fact that due to insufficient funds much of the energy and ingenuity of the researchers had to be diverted from the actual scientific problems to the solution of technological problems. The field of experimental physics still was saddled with the prejudice that a good experimental physicist had to be able to create the instruments necessary for his investigations out of "spit and wire." This is possible only in a very limited area of modern physics, which requires equipment of battleship complexity. The physicists who were not accustomed to dealing with technological problems were somewhat hesitant to utilize modern equipment in their experiments. In this respect a twofold problem had to be resolved: the university-trained physicists have little conception of technological or engineering procedures, and the technical-school-trained engineers have no concept of modern physics. The link was missing which could bind together the physicists and the engineers. This link was created through the KFKI with the assignment of physicists and engineers to the same research groups. In any event, both research and industry would benefit by a program of increased attention to the instruction of modern physics, and especially atomic physics, in the Technical University.

In the interest of greater exploitation of technical resources the Central Shop of the KFKI was formed with the primary purpose of the design and limited production of instruments which are not manufactured by industry. The Central Shop executes this task in 2 aspects: through the production of research equipment for the Institute which is not manufactured by industry, and through the production of prototypes of instruments and equipment which have been developed and tested within the Institute, in preparation for industrial production. The effectiveness of the Central Shop has been proved in the short time of its existence through the participation of the Central Shop in the solution of many technical problems which would have been impossible without well-developed technical direction.

Since the KFKI has been in existence it has had to participate in the solution of the very important question of the trend which should be followed in the scientific research work of the research institutes of

STAT



the Academy of Sciences. An emphasis on practical aspects in this work, which unfortunately was expressed by the leadership of many institutes, would have been a very dangerous trend. Such research work should further the development of theoretical physics, because only in this way can an adequate scientific preparation for the economic problems of the future be ensured. Theoretical research is very closely connected to practical problems, and the KFKI is a good example of the fact that many developments have resulted from work done in connection with theoretical research (i.e., radioactive radiation measurement instruments, spectroscopic excitation equipment) which can be of great service to the Hungarian instrument industry. Therefore it is very important that the results which have been achieved so far be placed at the disposal of industry, and that industry utilizes these results in the manufacture of instruments. If this is not done, or is delayed, Hungarian industry will be poorer by certain items which could be exported, and Hungary will be forced to manufacture large numbers of certain instruments for domestic use, which would be a very heavy drain on Hungary's production capacity. Unfortunately this type of coordination between the scientific institutes and industry is still quite involved and bureaucratic.

In conclusion it must be emphasized that compared to the status prior to Liberation the Party and the Government has placed unparalleled resources at the disposal of physical research and has made possible enormous development of the field of physics. Modern physical research is very expensive, especially if it is to be developed from a previously retarded state. It frequently has been stated by individuals who have lost sight of the former, that the development of physical research in Hungary has been too expensive and that the Government has spent too much money on the KFKI. This is true to the extent that the Party and the Government have spent more money on the development of physical research since Liberation than had ever been devoted to physical research prior to Liberation. This statement is dangerous, however, because it does not indicate that the later Government tasks connected with physical research (including primarily research devoted to the peaceful utilization of atomic energy) will require even greater investments. In order that these investments shall yield good returns adequate scientific preparations must be made well in advance for the accomplishment of the tasks. These tasks are integrally connected with the work which is directed toward the improvement of the living standards and further development of the culture of the Hungarian people during this history-making epoch, and which in the final result contribute to the building of Socialism.

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